

### REMARKS

Claims 1-3, 7, 21, 25 and 36 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Kondo 5,618,431. The presently claimed invention is directed to a process liquid filtration apparatus that uses super-buoyant particles having the following properties: 1) the super-buoyant particles have a specific gravity lower than one half of the specific gravity of the process liquid and 2) the super-buoyant particles have a specific size within the range of 0.1 micron to less than 1.0 mm. The filtration systems known in the prior art use buoyant material of greater than 1.0 mm diameter as the filter media. Based on the Applicant's research and the patents cited by the Examiner, the primary reason for the lack of filtration systems using small diameter buoyant media are the difficulties inherent in the filtering and cleaning processes required to effectively utilize small diameter filter media. These problems are exacerbated when using highly buoyant media as claimed in the present application. The present application solves these difficult problems by providing several novel engineering solutions to enable an extremely effective filtration system based upon small diameter super-buoyant media. The unique features described in the present application and their relationship with the prior patents cited by the Examiner, including Kondo, are described as follows:

**1. Super-buoyant particles having a diameter less than 1.0 mm respond significantly different than particles having a diameter greater than 1.0 mm.**

The Examiner has indicated that "particles having a size of slightly less than 1.0 mm, as included in the instant filtration apparatus, would appear to result in filtration properties, which would have been considered patentably indistinguishable from the use of particles having a size of 1 mm as disclosed in Kondo". The Examiner's comment is severely limited because it ignores the substantial amount of information already presented to the Examiner in this

application, by Applicant's prior Responses to the Examiner, and in the material cited in the Responses that was derived from previously-awarded patents. As Applicant has described before, it is possible to use basic mathematics to calculate the approximate surface area of filtration media of a specific diameter. Applicant has provided Table 1 which presents the calculated approximate surface area per cubic centimeter of media for specific filter media diameters.

Table 1. Surface area of filtration media as a function of media diameter.

Media Diameter	Media Surface Area per Cubic Centimeter
10 mm	314 sq. mm / cc
5 mm	629 sq. mm / cc
1 mm (= 1000 $\mu$ )	3143 sq. mm / cc
500 $\mu$	6285 sq. mm / cc
100 $\mu$	314,250 sq. mm / cc
50 $\mu$	628,500 sq. mm / cc

From Table 1, it is clear that reducing media diameter greatly increases the surface area available. The difference in surface area of a 5 mm particle and a 1 mm particle produces an increase in surface area of about 500%. To any practitioner in the art, this change is clearly a substantial one, as it directly affects the magnitude of interactions that occur between the filter media particles in both clean and "dirty" states. When the filtration media is clean, as Applicant has already pointed out, inter-particulate forces (i.e. electrostatic) between the media particles play a critical role in determining the functionality of the filter. Paragraph [0045] of the present application states:

"[0045] The second factor in selecting the type of superbuoyant filter media is the attraction of the filter media particles to one another. If, for instance, there is a weak electrostatic attraction between the filter media particles, the particles tend to adhere to one another. As a consequence, through selection of media material (e.g., plastic, ceramic, or glass), this electrostatic effect can be utilized to assist the filter media in

forming a coherent mass that floats better on the surface of the process liquid, as well as assisting in attraction and removal of contaminant particles from the process liquid. **If the electrostatic attraction between the media particles is too great, however, the particles will tend to stick to one another too strongly, thus forming clumps which can cause bed inhomogeneities or interfere with the removal of contaminants from the bed during backwashing.** In this later case, it may be necessary to include in the filter housing, a means of electrically grounding the media to remove the charge.”  
(emphasis added)

It is especially important to note the highlighted sentence in paragraph [0045] provided above. As identified in the present application and by Kondo, this attractive phenomenon, which is well-known to practitioners in the art, can severely hamper the efficiency of filters that utilize small diameter media particles both when the media particles are clean and when they are “dirty” (i.e. have captured contaminant particles). However, the exact diameter of the filter media at which these attractive effects begin to have a significant effect on filter performance (e.g. blocking of flow as described by Kondo) is dependent on not only the media diameter, but also upon the material from which the media is formed (i.e. plastic, glass, ceramic, etc.) and upon the fluid that is being filtered through the media. Clearly, because of the enormous relative increase in media surface area that occurs when reducing average filter media diameter, practitioners of the art realize that these effects are noticeable by the time the average particle size reaches 1 mm. This realization is reflected not only in the Schwartzkopf application and in the Kondo patent, but also specifically in the Hsiung patent, which states the preferred diameter of the filter media to be 1.5 to 20.0 mm in diameter (Column 4, lines 55-58). In addition, this realization is reflected in dimensional data for the minimum filter media diameter that can be inferred from structural features described in the Iwatani and Kreusch patents, which (as presented to the Examiner in previous Responses), are approximately 1.8 mm to 6 mm in diameter, respectively. Thus, in

contrast to the Examiner's summary statement, it should be extremely clear from the information presented above that slight variations – including reductions – in diameter of filter media around 1 mm in diameter have extremely significant effects on the behavior of the filter media and thus on the operation of the filter. These effects are the reasons that the cited patents openly state a useful minimum media diameter of 1 mm or greater.

The second overall, fundamental issue with the use of small-diameter, buoyant and super-buoyant media, which concerns the effect of contaminant particles trapped by the filter media, has been described in the present application, as well as in Applicant's prior Responses. For example, in a previous Response submitted to the Examiner, the Applicant stated the following:

**“5. Small super-buoyant particles have a tendency to clump.** Finally, as provided in Applicant's previous response, one of ordinary skill in the art would not be motivated to use particles of the size claimed in the present application because of the problems that are encountered during operation. Primarily, due to the high surface area of the small diameter media, contaminant particles that fill the interstices between the media particles can act like a glue which makes the media particles adhere to one another and form clumps which lead to the formation of non-homogeneities within the bed. In the case of small diameter buoyant media, the light weight of the media particles makes it even more difficult to break these clumps apart to clean the media particles. Because the backwash systems previously used in systems including buoyant particles, such as the Hsiung and Iwatani, are relatively gentle in nature, these non-homogeneities cannot be removed from the bed, and the bed performance declines.”

Several paragraphs in the present Application address this exact issue by describing a novel backwash method that is directed specifically at solving the problem of cleaning filter media of less than 1 mm in diameter (see, for Example, paragraphs [0054], [0055], and [0087]). It is particularly important to recognize the significance of the last two sentences of paragraph [0087] that provides the following:

“When the filter bed consists of extremely fine particles, it can compress against the lower surface of the bed support 16 during filtration, thus forming a hard, compressed layer on the surface of the filter bed support. In such cases, it is usually necessary to have one or more additional spray nozzles that spray vertically upward to dislodge the compressed bed particles and wash them into the lower section of the filter housing 13.”

This bed compression occurs as a result of the combination between the high pressure required to force the fluid through the small diameter filter media, the inter-particle forces that bind the media particles together, and the contaminant particles trapped by the filter bed which act as a glue to make the filter media particles adhere to one another. In the worst cases, the media form a solid, clay-like plug that can only be loosened by direct fluid spray from beneath the media bed (as described above). The above description provides ample evidence that small diameter media behave in a fashion that is not only different from that described in the patents already cited above (Kondo et al., Kreusch et. al., Iwatani, and Hsiung, et. al.), but also in a fashion that those above-cited patents cannot accommodate by the nature of their designs. Clearly, this also means that it is not possible for a practitioner of the art to learn from the information contained in these patents how to successfully accommodate the backwash cleaning of small diameter filter media.

**2. The Kondo reference has a number of features that render it unusable for filter media that are smaller than 1 mm in diameter.**

The focal point of the Kondo patent is clearly the method of backwashing the buoyant media and has a number of features that render it unusable for filter media that are smaller than 1 mm in diameter. The material contained in Kondo is not only **not** applicable to the small diameter super-buoyant media described by the present application, but the material actually

teaches away from the claimed invention because of the non-functional nature of the Kondo design.

**A. Present invention uses increased pressure**

Specifically, one of the most significant consequences of utilizing small diameter media described in the present application is the increase in pressure required to pump process fluid through the filter bed. The pressure required to pump process fluid through the filter media in the presently claimed system ranges from approximately 20-150 psi (see claim 9 of the present application), or from 100 to almost 500 times greater than the pressure required to pump water through the filter described in Hsiung (0.31 to 0.45 psi as cited in Column 8, lines 13-14) which calls for the use of media in a size range almost identical to that called out by Kondo (from 1.5 to 20 mm in average diameter – Hsiung, Column 4, line 62). Similarly, the pressure required to pump water through a media bed, as described in Kondo, is only 0.51 psi (Column 9, line 32) for a bed formed of 4 mm (average) diameter particles. Clearly, the pressure requirements dictated by the media specified in both the Hsiung and Kondo patents are substantially lower than the requirements specified in the present application. The need to accommodate this increased pressure dictates a series of unique structural and structural reinforcement features to form a reinforced media retaining plate, which are described in the present application. Since none of the prior art appreciates these increased pressures, it would not be obvious to use the teachings of the prior art to obtain the presently claimed invention.

**B. Filter Media Retaining Plate Prevention of Fluid Backflow**

One of the requirements that evolves from the need for a reinforced filter media retaining plate with smaller openings to accommodate the use of smaller diameter filter media is that the retaining plate won't allow fluid to enter the filter chamber during fluid draining to allow a

vortex to develop for media cleaning, as described in the Kondo patent. Specifically, Kondo (column 3, lines 8-25) states the following:

“In the first, basic, embodiment of the invention, since the water is rapidly discharged from beneath the filter layer to outside the treating tank, the water level above the filter layer drops, and at the same time, the filter layer itself descends in the treating tank, while maintaining its initial gathered state.

Similarly, in the second embodiment, when the water level in the water seal descends to break a seal, which is caused by the air supplied into the air sump, the air in the air sump instantly passes through the air injection pipe to be discharged through the cleaning water discharge pipe.

As a result, by momentary air flow injection, water in the bottom of the treating tank can be discharged outside the treating tank through the cleaning water discharge pipe, and water in the bottom of the tank flows into the empty air sump, so that a water level above the filter layer suddenly descends. The filter (sic) layer itself simultaneously descends in the treating tank while maintaining its initial gathered state.”

In contrast, the present application, at paragraph [0050] states:

“Using smaller diameter media or thicker media beds carry a power penalty, however, as a more powerful, high pressure pump is required to force the process liquid through such a super-buoyant media bed. To resist the pressure required to move the process liquid through these beds, a strong multi-component “sandwich” is used as a bed restraint 16 (FIG. 2,3).”

The design of this multi-component sandwich must not only resist the higher pump pressures required for the use of filter media smaller than 1 mm in diameter, but it must also insure that the component layer that is in contact with the filter media has openings that are smaller than the diameter of the filter media being used. If the openings in this component layer are not smaller

than the diameter of the filter media being used, the media will escape through the bed restraint and the filtration process will cease to operate.

As a consequent of the Applicant's stated requirement for high pump pressure to force fluid through the media and the bed restrain, there is no possibility that the backwash system described in Kondo will function with media having a diameter of less than 1 mm. The Kondo backwash system, as described in the first paragraph of this section, is clearly a gravity-driven process in which the cleaned fluid above the filter media retaining plate is drained back down into the filter chamber through the retaining plate and the media itself, and this draining effect is crucial to the establishment of the vortex that Kondo specifies is the central mechanism for the cleaning of the media. In the present Application, this gravity-induced rapid drain will not occur (and thus no cleansing vortex will be formed), as the pressure head present in the fluid above the media retaining plate is not high enough to force the fluid to flow back through the retaining plate and the media in a rapid fashion as needed by the Kondo system for proper backwash operation. Thus, the backwash system of the Kondo reference is not designed to handle small diameter particles as claimed by the present invention.

### **C. Effect of Media on Establishment of Vortex**

Kondo (Column 11, Lines 54-63) states that:

“The invention was made by repeating numerous floating filter medium cleaning tests on the basis of such finding, and is grounded on a specified relationship between the specific gravity and particle size of the floating filter medium forming the filter layer (filling layer) and a flow rate of the cleaning water discharged from beneath the filter layer in a cleaning operation, so that the entire region of the filter layer may be spread efficiently with a small volume of cleaning water, thereby completely separating and remove the excess sludge deposited on the floating filter medium.”

This section from Kondo et. al. clearly acknowledges that there is a specific, required relationship "... between the specific gravity and particle size of the floating filter medium forming the filter layer (filling layer) and a flow rate of the cleaning water discharged from beneath the filter layer in a cleaning operation...", in order for the filter layer to be spread efficiently for cleaning. In contrast, the present application, in paragraph [0038] states

"In contrast, super-buoyant media filter particles (B in FIG. 1) do not behave as though they are part of the process liquid mass. Instead, they form a mass that floats on the surface of the process liquid, largely independent of, and isolated from, the movements of the process liquid beneath. Horizontal movements of the liquid beneath the floating, super-buoyant media have virtually no effect on the media, and thus such movements do not tend to cause significant movement of the super-buoyant media bed. In essence, the super-buoyant media described herein behave much like a cork floating on a water surface."

Also, the present application states, at paragraph [0087]:

"As the liquid drains in the collection reservoir 48, air enters the filter housing through valve 22 and conduit 21, and the liquid level in the housing drops. When the liquid level reaches the bottom of the filter bed, the super-buoyant bed media 14 (which is lighter than the process liquid, and is thus still pressed against the bed support 16 as it floats on top of the process liquid begins to descent in the filter housing 13 as it floats on the descending process liquid. Filter bed 14 is allowed to fall until the top surface of the filter bed has fallen below the midpoint of the filter housing 13, as indicated to the controller 54 by the lower fluid level sensor 18 via wire 106. At this point, the controller 54 closes drain valve 46 via wire 102 and the backwash spray process is initiated to clean the filter bed."

The backwash process is pictured in FIG. 5 of the present application. FIG. 5 is a diagrammatic view of the backwash process that illustrates the various positional relationships of the filter bed to the backwash spray nozzle during a complete filter and backwash cycle application. This

figure shows directly how the filter bed raises and lowers as a homogenous “plug” within the filter housing. This behavior is due the adhesion of the filter media particles to one another during both filtration and backwash operations. This behavior is also what prevents the bed from being disrupted by the draining of fluid from the filter chamber, as described by Kondo. The net behavior of the small diameter, super-buoyant media during backwash described in the present application is this:

- 1) as the clean fluid drains from the section above the media retaining plate into the bed, the bed particles are not disturbed because of the high particulate interaction and adhesion that takes place in the bed
- 2) the bed particles will not move downward in the filter housing until the fluid level has dropped below the bottom edge of the filter media mass (unlike the description in Kondo et. al., where the media mass begins to move downward as the “water level above the filter layer drops, and at the same time, the filter layer itself descends in the treating tank, while maintaining its initial gathered state”, Kondo et. al. Column 3, Lines 8-25).
- 3) even after the bed has moved downward in the filter housing, the media behave as a homogenous mass, immune to the horizontal movements of the fluid at the bottom of the bed (and thus unable to enter into the establishment of the vortex cleaning mechanism described by Kondo et. al.)

Thus, in the same fashion as previously stated, this finding illustrates the non-functionality of the Kondo reference for the use of small diameter super-buoyant media as described in the present application.

In summary, the exact problems involving the use of buoyant filter media of less than 1.0 mm in diameter is specifically described in the present application. The novel filter design and

backwash mechanism described in the present application are the only methods described to date that allow the use of such small particle media without experiencing the problems described by the cited patents.

**3. The Kondo reference itself specifically teaches that particles less than 1.0 mm may not be used.**

The Examiner has asserted that “particles having a size of slightly less than 1.0 mm, as included in the instant filtration apparatus, would appear to result in filtration properties, which would have been considered patentably indistinguishable from the use of particles having a size of 1 mm as disclosed in Kondo”. However, the Examiner’s *prima facie* case of obviousness may be rebutted by showing that the reference “teaches away” from the claimed invention in any material respect. As previously stated by the Applicant, the “filtration properties” of the filter particles are not the only property of the filter particle that affects the operation of a liquid filtration apparatus. In order for the filtration apparatus to operate effectively, “dirty” filter media must be able to pass by the filter particles in order to remove the contaminants. In the case of super-buoyant particles of the size claimed by the present application, clogging of the filter is a significant problem due to the electrostatic attraction of such small particles. This problem is expressed in the prior art in many ways. First, any super-buoyant particles located in the prior art are identified as being larger than 1.0 mm. Second, the Kondo reference *specifically teaches* that particles “smaller than 1 mm” result in the “growth of biological membrane or blocking of flow through the filter medium” (see column 5, lines 63-67). Furthermore, the Kondo reference only provides a specific Example including filter particles having a diameter of 4 mm (see column 9, lines 22-25). Since the claims of the present invention are directed to “a filter bed for removing particulates from a process liquid”, it is clearly material that the process

liquid must be capable of moving through the filter bed which contains the super-buoyant particles. Since the Kondo reference clearly teaches that filter particles “smaller than 1 mm” would provide an inoperable filter apparatus, the Kondo reference clearly “teaches away” from the claimed invention.

“A reference may be said to teach away when a person of ordinary skill, upon reading the reference, would be discouraged from following the path set out in the reference, or would be led in a direction divergent from the path that was taken by the applicant”, In re Gurley, 27 F.3d551, 31 USPQ2d 1130 (Fed.Cir. 1994). Since the Kondo reference clearly teaches one of ordinary skill that the flow through the filter medium would be blocked if one used filter particles that were “small than 1 mm”, the Kondo reference discourages one of ordinary skill from following a path directed towards the use of such filter particles that are less than 1mm. Furthermore, the Kondo reference provides that filter particles “smaller than 1 mm” would result in an inoperable apparatus that included “growth on the biological membrane or blocking of flow through the filter medium”. It is clearly established patent law, that a modification that would result in an inoperable device “teaches away”.

Since the Kondo reference itself teaches that the apparatus cannot operate within the range claimed by the present application, Applicant is not required to provide any further “comparative evidence”. Additionally, Applicant is not required to provide a “showing of unexpected results” when the prior art “teaches away” from the claimed invention.

Contrary to the Examiner’s assertion, Applicant is not required to disclose in his specification how a filter particle size of less than 1 mm would “overcome the problems disclosed in Kondo”. However, in order to expedite prosecution, the Applicant has provided

exhaustive details as to how the Kondo reference would not operate with filter particles of less than 1 mm.

Furthermore, with regard to patentability, it is immaterial that the specification of the present invention includes filter particles greater than 1 mm. Applicant submits that the filtration apparatus is capable of being operated using super-buoyant filter particles having a diameter of greater than 1 mm. However, Applicant asserts that his claimed invention is a filtration apparatus capable of being operated using super-buoyant filter particles having a diameter of less than 1 mm. The prior art does not show that a filtration apparatus exists using super-buoyant particles having a diameter of less than 1 mm. Furthermore, the prior art teaches away from using super-buoyant particles having the claimed size.

For the foregoing reasons, Applicant submits that the rejection has been overcome and requests reconsideration and allowance of the claims.

Claim 22 and 23 stands rejected under 35 U.S.C. 103(a) as being unpatentable over Kondo et al. as applied above, and further in view of Iwatani, 4,198,301. For the reasons stated above, Applicant submits that the rejection has been overcome and respectfully requests reconsideration and allowance of the claims.

Claims 32 and 35 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Kondo et al. as above, and further in view of Hsiung, 4,608,181. For the reasons stated above, Applicant submits that the rejection has been overcome and respectfully requests reconsideration and allowance of the claims.

Claim 33 stands rejected under 35 U.S.C. 103(a) as being unpatentable over Kondo in view of Hsiung et al as above, and further in view of Cochrane, 4,211,656 For the reasons stated above, Applicant submits that the rejection has been overcome and respectfully requests reconsideration and allowance of the claims.

Claims 6, 24, and 29-31 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Kondo et al as above, and further in view of Cochrane, 4,211,656. For the reasons stated above, Applicant submits that the rejection has been overcome and respectfully requests reconsideration and allowance of the claims.

Claim 10 stands rejected under 35 U.S.C. 103(a) as being unpatentable over Kondo et al. as above, and further in view of Daley, 5,178,772. For the reasons stated above, Applicant submits that the rejection has been overcome and respectfully requests reconsideration and allowance of the claims.

Claim 26 stands rejected under 35 U.S.C. 103(a) as being unpatentable over Kondo et al. as above, and further in view of Muller, 4,383,920. For the reasons stated above, Applicant submits that the rejection has been overcome and respectfully requests reconsideration and allowance of the claims.

Claim 27 stands rejected under 35 U.S.C. 103(a) as being unpatentable over Kondo et al. as above, and further in view of Holland, 6,067,653, and Banks, 4,885,083. For the reasons

stated above, Applicant submits that the rejection has been overcome and respectfully requests reconsideration and allowance of the claims.

Claims 1-5, 7-10, 21-25, 27, 28, and 32-36 stand rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-4 of U.S. Patent No. 6,638,422. Applicant is prepared to submit a terminal disclaimer to overcome this rejection upon notification of allowable subject matter. The Examiner is invited to contact the undersigned attorney to expedite the filing of the disclaimer.

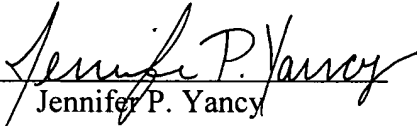
Claim 26 stands rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-4 of U.S. Patent No. 6,638,422 in view of Muller, 4,383,920. Applicant is prepared to submit a terminal disclaimer to overcome this rejection upon notification of allowable subject matter. The Examiner is invited to contact the undersigned attorney to expedite the filing of the disclaimer.

Claims 6, 24, and 29-31 stand rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-4 of U.S. Patent No. 6,638,422 in view of Cochrane, 4,211,656. Applicant is prepared to submit a terminal disclaimer to overcome this rejection upon notification of allowable subject matter. The Examiner is invited to contact the undersigned attorney to expedite the filing of the disclaimer.

Claims 28 and 34 are objected to as being dependent upon a rejected base claim. For the reasons stated above, Applicant submits that the objection should be withdrawn and respectfully requests reconsideration and allowance of the claims.

For the foregoing reasons, Applicant submits that the claims of the application are now in condition for allowance. Therefore, Applicant respectfully requests reconsideration and allowance of the claims.

Respectfully submitted,

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